DOCUMENT RESUME

ED 221 655 CE 032 952

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TITLE Medical Laboratory Services. Student's Manual. Cluster Core for Health Occupations Education.
INSTITUTION Texas Univ., Austin. Center for Occupational Curriculum Development.
PUB DATE 81
NOTE 34p.; For a related document see CE 032 953.
AVAILABLE FROM Center for Occupational Curriculum Development, The University of Texas at Austin, P.O. Box 7218, Austin, TX 78712 (Stock No. HO-101-S, $5.00).

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Allied Health Occupations Education; Behavioral Objectives; *Biomedical Equipment; Check Lists; *Equipment Maintenance; Individualized Instruction; Instructional Materials; Interpersonal Competence; Job Skills; Laboratory Equipment; *Laboratory Procedures; Laboratory Safety; *Medical Laboratory Assistants; *Medical Technologists; Postsecondary Education; Rating Scales

ABSTRACT

This student's manual on medical laboratory services is one of a series of self-contained, individualized materials for students enrolled in training within the allied health field. It includes competencies that are associated with the performance of skills common to several occupations in the medical laboratory. The material is intended for use under instructor supervision. Materials provided in this manual include a progress chart and rating scale of specific competencies to be used after completion of the manual; five units; and a bibliography. Each unit follows this format: objectives, list of new terms and definitions, and information to aid the learner in mastering the objectives. These topics are covered: patient-worker relations, care of supplies and work area, safety in the laboratory, collection and transportation of specimens, and use and maintenance of laboratory equipment. (YLB)

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ED221655

Medical Laboratory Services

Cluster Core for
Health Occupations Education

Student's Manual

By
Catherine Williams

Published by
Center for Occupational Curriculum Development
Division of Continuing Education
The University of Texas at Austin

CE 032 952

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Art Director / Ben E. Smith
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Publications Manager / James L. Cockrum

Stock Number HO 101 S

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Foreword

This publication is one of the new series of self-contained materials for students enrolled in training within the allied health field. It includes competencies that are associated with the performance of skills common to several occupations in the medical laboratory.

Although the material is individualized, it should be used under the supervision of the instructor. For that reason, two basic publications are offered—a student's manual and an instructor's guide.

The student's manual includes the competencies, progress chart, objectives, and information. The instructor's guide provides the core competencies, a teaching outline of the information, learning activities, and unit tests. Although the manual and the guide are copyrighted, feel free to reproduce copies of the learning activities and unit tests.

Jack E. Robertson, Director
Center for Occupational Curriculum Development

Progress Chart

Medical Laboratory Services
Specific Competencies

Directions: After completing this package, ask your instructor to rate your job preparedness by completing this chart for the areas listed.

Rating Scale:

3–*Skilled:* can perform with little or no supervision.
2–*Partial Skill:* can perform but requires supervision.
1–*Introduction:* introduced to occupational area.

A. Patient-Worker Relations

	3	2	1
1. Receive patient.			
2. Treat patient as important person.			
3. Use patient's name.			
4. Explain delay.			
5. Explain procedures.			
6. Reassure fearful patient.			
7. Cope with a hostile patient.			
8. Reassure patients during blood collection.			
9. Provide special consideration for children.			
10. Dismiss patient at end of laboratory procedure.			
11. Avoid giving patient test results.			

B. Care of Supplies and Work Area

1. Clean and maintain the work area and equipment.			
2. Clean area and equipment aseptically.			
3. Log incoming and outgoing specimens.			
4. Maintain files of laboratory records or reports.			
5. Organize storage area for equipment, supplies, and reagents.			

C. Safety in the Laboratory

1. Explain procedures for fire prevention and control.			
2. Dispose of contaminated materials and equipment safely.			
3. Follow safety procedures in operating lab equipment.			
5. Identify safety practices in the laboratory.			
6. Use safety shower.			
7. Wash eyes.			
8. Recognize procedure and purpose of reporting accidents.			
9. Identify hazards indicated by the National Fire Protection Association emblems.			

D. Collection and Transport of Specimens

3	2	1

1. Collect blood samples.
2. Collect fecal specimens.
3. Collect urine specimens.
4. Prepare specimens for testing.
5. Prepare specimens for shipment.

E. Use and Maintenance of Laboratory Equipment

1. Use a centrifuge.
2. Identify a microhematocrit centrifuge.
3. Recognize a refrigerated centrifuge.
4. Identify parts of a compound microscope.
5. Use a compound microscope.
6. Identify volumetric and calibrated pipettes.
7. Measure solutions with a pipette.
8. Use a water bath or heat block.
9. Check temperature of constant temperature appliances.

Instructor *Date*

UNIT 1

Patient-Worker Relations

Objectives: After completing this unit, you will be able to–

1. receive the patient;
2. treat the patient as an important person;
3. use the patient's name;
4. explain delays if necessary;
5. explain procedures;
6. reassure fearful patients;
7. cope with a hostile patient;
8. reassure patients during blood collection;
9. provide special consideration for children;
10. dismiss patient at end of procedure; and
11. avoid giving the patient test results.

New Terms and Definitions

apprehensive–anxious, worried.
calm–quiet, still.
concerned–interested, affected, involved.
considerate–thoughtful of others and their feelings.
cooperative–willing to work together.
courteous–polite, thoughtful of others.
friendly–having the attitude of a friend; kind.
hostile–unfriendly; enemy.
optimistic–inclined to look on the bright side of things.
personality–the personal or individual quality that makes one different, or act differently, from another.
professional–having to do with a profession.
prompt–on time.
responsible–trustworthy, reliable.
sympathetic–sharing and understanding the feelings of others.

Receive Patients

Whether you work in a small clinic or in a large hospital laboratory, you will receive patients. You may be the first professional person they see. It is always your responsibility to make them welcome and to try to establish a comfortable relationship. Every patient has a right to expect courteous treatment no matter how busy you may be and regardless of social or economic status. All patients' problems are of paramount importance to them, even if they may seem routine or trivial to you. Remember, no one wants to be ill. No one wants to go to the doctor's office or hospital. Every patient comes to you unwillingly. This makes it even more important that you make their visit as pleasant as possible. An attitude of friendliness, concern, and optimism helps patients to cope with their problems. Moreover, you will get great satisfaction from helping patients.

Here are some suggestions that could help to establish good patient relations.

Treat Patients as Important Persons

Treat every individual as an important person. Make the patient aware that you are there to serve. Listen to what the person has to say. Try to put yourself in the other person's position and treat him/her accordingly. A friendly comment will almost always bring about a friendly response. Try to adjust to the individual personality of each patient while maintaining an overall friendly atmosphere.

Use Patient's Name

Use the patient's name. This is important for identification and for indicating interest in the patient as a person. Make a real effort to pronounce each name correctly. Never imply that you think the name is strange, awkward, or difficult. Everyone feels protective of their name and resents inaccuracies in spelling and pronounciation.

Explain Delays

Another way to show your interest in the patient is by prompt attention. If there must be a delay, explain the reason to the patient. Estimate the length of extra time involved. Nothing adds to the fears of patients as much as waiting for appointments. Not only are they apprehensive, but a long wait implies that they are not important, that you are making them waste their time. Everyone has something they would rather do than wait unreasonable lengths of time in the clinic or hospital.

Explain Procedures

Patients will usually be more relaxed and cooperative if you can explain the procedure the doctor has ordered. Mention any way in which the patient may assist in the procedure.

Reassure Fearful Patients

Many patients come for treatment of serious illness, or for surgery. Laboratory screening may be the first step of treatment for a frightened person facing a very real problem. Try to reassure patients if they talk about their fears. Listen carefully, and show genuine interest. Some patients can admit fears to you that they feel they must hide from family and friends. Offer sympathy. Never joke or laugh about such fears.

Cope with Hostile Patients

If a patient is hostile, respond calmly. Hostility is often the expression of fear or worry. It may indicate that the patient is frightened, lonely, and feeling helpless. The pressure of problems at home or at work may be adding to the uneasiness or anxiety of illness. Most patients will cooperate if you remain calm and reasonable.

However, if a patient refuses a test or procedure, do not argue. Avoid the attitude that you know what's best and that the patient is ridiculous. Simply report the refusal to the physician or supervisor in the laboratory.

Reassure Patients During Blood Collection

A common laboratory procedure is the collection of blood. Many people are frightened by the sight of needles and lancets. It is well to remember that such patients need extra assurance and consideration when blood is collected. You must remember that what is routine to you is of great personal importance to each patient.

Provide Special Consideration for Children

When teenagers and older children are approached for testing, they may be treated as adults. Explain what you plan to do, and proceed. Young children and infants do not understand directions and cannot comprehend why they must be "hurt." Immobilize the child if necessary, and proceed as rapidly as possible. Sometimes parents may be asked to hold the child. At other times, a disinterested adult should restrain the infant, after the parent has left the room. Never tell a child "this isn't going to hurt."

Dismiss Patient at End of Procedure

When tests and procedures have been finished according to the doctors' orders, courteously instruct patients about the next procedure, or direct them to the next department. You may need to escort them to the next station because the medical facility may seem frightening and confusing to a patient.

Avoid Giving Test Results

The results of laboratory tests are always given to the patient by the doctor. The medical laboratory worker never gives test results to the patient. It is sometimes hard to avoid discussing laboratory results when meeting with a patient for a second time or on a continuing basis. Nevertheless, it is always the responsibility of the doctor to give the patient test results.

UNIT 2

Care of Supplies and Work Area

Objectives: After completing this unit, you will be able to–

1. clean and maintain the work area and equipment;
2. clean the area and equipment aseptically;
3. log incoming and outgoing specimens;
4. maintain files of laboratory records or reports; and
5. organize the storage area for equipment, supplies, and reagents.

New Terms and Definitions

aseptic–free from disease-causing germs.
aspiration–to draw fluid from a body cavity.
autoclave–apparatus for sterilization by steam under pressure.
biopsy–to take out a small piece of tissue for microscopic examination.
contaminated–unsterile or unclean as a result of direct contact or exposure to germs.
disinfectant–an agent that kills bacteria.
infectious–capable of causing infection or disease.
materiél–equipment, apparatus, and supplies used by an institution.
reagent–chemical substance.
resection–to cut off a portion of a bone or other body structure.
sterilization–to make free of all living germs.
warranty–a written guarantee of the maker's responsibility for a product, including repair or replacement of defective parts.

Clean and Maintain Work Area and Equipment

The cleaning and maintenance of the work area of the laboratory is usually the responsibility of the medical laboratory worker. Work tables or benches must be kept free of clutter. Spills should be wiped up at once. The entire work area must be dusted or cleaned with a damp cloth at the end of each work day.

If you work in a small clinic or a doctor's office, you may be responsible for keeping the reception room neat and attractive. Patients will be more comfortable and less apprehensive in pleasant surroundings. The housekeeping department or janitorial service is probably responsible for heavy cleaning, such as the general cleaning of floors, walls, and windows. However, the medical laboratory worker should check to be sure that the room is adequately cleaned. He or she may be responsible for keeping the room neat as patients come and go during the day. Papers, drink bottles, cans, or cups must be removed. Ashtrays must be emptied and cleaned. (Some waiting rooms have "No Smoking" signs. Others do not have ashtrays in sight. Thus, the patient must ask for an ashtray if he or she wishes to smoke.) Odors that may be disagreeable to patients should be carefully controlled. Room fresheners or sprays may help. It is sometimes hard for the medical laboratory worker to remember that odors to which she or he has become accustomed may be obnoxious to patients. The

temperature and ventilation should be kept at a comfortable level.

Various types of surfaces found in the service area require different types of cleaning. *Chrome* and *stainless steel* should be wiped clean with a damp cloth and polished with a dry cloth. A nonscratching cleanser followed by polish will remove most stains.

Enamel surfaces are cleaned by wiping with a damp cloth and polishing with a dry cloth. Light waxing at intervals helps to maintain the surface. Chipped places may be repaired with enamel finish.

Wood surfaces should be dusted daily with a soft cloth and waxed or polished frequently. This is usually done by the housekeeping department or janitorial service.

Plastic surfaces, as well as glass or ceramic tile, are cleaned with a mild soap or detergent, rinsed with water, and dried with a soft cloth.

Clean Area and Equipment Aseptically

The above cleaning procedures are adequate for general cleaning. If the work area and equipment require aseptic cleaning, then different materials must be used. *Aseptic cleaning* means that you are ridding the area to be cleaned from disease-causing germs. To clean tabletops aseptically, they should be washed with a disinfectant. A *disinfectant* is a chemical that kills harmful bacteria.

Contaminated glassware is placed in porcelain or stainless steel containers with snug-fitting tops until it can be completely sterilized. Pipettes may be placed in cylindrical jars or rectangular pans containing disinfectant. The contaminated glassware is then autoclaved to ensure the destruction of harmful bacteria.

Contaminated specimen cartons, applicators, tongue depressors, cotton, and other combustible material should be discarded into a garbage pail with a tight lid. The pail should be lined with a disposable bag so that the entire contents of the garbage can be removed and placed directly into the incinerator. As few workers as possible should handle contaminated materials.

All infectious materials, such as sputum from tuberculous patients, must be autoclaved before discarding.

Common Methods of Sterilization

The commonly used methods of sterilization of contaminated equipment are chemical, hot air (dry heat), and autoclaving.

Chemical sterilization is used to sterilize items that would be destroyed by heat, such as polyethylene items, lenses, or electrical equipment. Items are sterilized by exposure to ethylene oxide for 3 to 5 hours. Articles must be aired after chemical sterilization to avoid the hazard of toxic residue.

Dry heat may be used to sterilize glassware or metal instruments. A temperature of 160°C for 2 hours is usually used.

The *autoclave* sterilizes by the use of steam under pressure. It is used to sterilize glassware, sharp-edged or hinged instruments, syringes, needles, rubber catheters, drains, or linens.

The choice of sterilization methods depends on the type of material to be decontaminated and the equipment available in your laboratory.

In some instances, disinfection is adequate for decontamination. Some items may be disinfected by placing them in boiling water for 10 minutes. Commonly used disinfectants are isopropyl or ethyl alcohol in 70% concentration. There are several commercially prepared disinfectants. They must be used in the precise concentration and for the exact time specified by the manufacturer.

The means and methods of sterilization and disinfection may vary depending on the needs of the individual institution. Even so, the work area, equipment used, and contaminated specimens must all be decontaminated and made safe to protect workers and patients.

Types of Specimens Received

Many types of specimens are received in the medical laboratory. These include any body excretion such as urine, feces, or sputum. Other specimens may be obtained by needle aspira-

tion, such as blood, spinal fluid, pleural fluid, and body cells from the liver, sternum, or kidney. Tissue obtained from resections or from biopsies is sent to the laboratory for examination.

Another type of laboratory specimen is a *smear*. This is obtained by touching an area with a cotton swab, then smearing the swab on a microscope slide. Such material is most commonly obtained from the nose, throat, or a wound. Many other types of specimens are received in the laboratory, depending on the capability of the laboratory and the need of the patient.

Logging Incoming and Outgoing Specimens

Most laboratories have an established routine for receiving specimens. It is necessary to have a definite area where specimens may be placed when they arrive in the laboratory. It may be one of the duties of the medical laboratory worker to identify incoming specimens and route them to the correct work area.

In every laboratory, some method of logging or recording specimens must be devised. The method depends on the type of institution, the type of specimen, and the number of specimens handled.

In very large laboratories, *numbering systems* and *color coding* are used. The color coding indicates the various divisions of the laboratory. This makes it easier to route specimens quickly to the correct division. Numbers may be used to identify the specimen, the accompanying information, and all the tests required to complete the laboratory examination. A permanent record of the test may be filed using the same number. There are many types of numbering devices on the market, such as numbering machines or numbered adhesive tapes.

In smaller laboratories where there are fewer specimens to handle, simpler logging methods may be used. A *request form* with a single carbon copy may be satisfactory. This form indicates the type of test ordered and all the information needed to identify the patient, including the patient's chart number. This number is affixed to the specimen. When testing is complete, the original request, with test results, is returned to the patient's chart, using the number to ensure identification. The copy is filed in the laboratory.

In very small laboratories, specimens may be numbered with a marking pencil, and the same number recorded on the accompanying request sheet. Whatever method of logging is used, mistakes in identification of specimens are intolerable. All logging methods should be aimed at elimination of error.

Every means possible should be used to identify a specimen with incomplete information. Keep in mind that no laboratory specimens are unimportant. Some are extremely difficult to collect, and, indeed, it is impossible to replace most laboratory specimens. In any case, if it is impossible to identify a specimen correctly, it must be discarded.

Packaging Outgoing Specimens

Few laboratories are equipped to conduct every laboratory test that may be required. Some specimens must be sent to other laboratories. Outgoing specimens must be packaged in correct or suitable containers. They must be correctly labeled. The label should include all pertinent information. This includes the patient's name, address, and chart number; the date and hour of collection; the type of specimen; the exact tests ordered; and the name and address of the attending physician. This same information should be filed in the sending laboratory to ensure identification of the specimen, to verify having sent the specimen, and for patient billing.

Maintain Files of Laboratory Records or Reports

Copies of the results of every laboratory test performed are kept in the medical facility. These copies are used to determine charges for laboratory services, to replace reports that may

have been lost or misplaced, and to provide information and statistics for research.

Modern electronic equipment has made it possible to keep large numbers of laboratory records and reports in a small space. Even smaller medical facilities frequently use microfilm to store laboratory reports. In some laboratories, however, medical laboratory workers may be required to hand-file laboratory reports. Reports may be filed under the patient's name, patient's number, type of test, or even the name of the attending physician. Whatever method is used, filing should be an easy task. It must be arranged so that anyone can use the filing system and quickly retrieve the information needed.

Organize Storage Areas

Every medical facility must store supplies or materiéls. The methods used depend on the needs of the individual institution. Most hospitals have a large storage area. Supplies are ordered in quantity and dispensed as needed. Usually a written request is required. It is the responsibility of the materiéls department to maintain an inventory of these supplies and order additional items as they are needed.

In smaller offices, the medical laboratory worker may be assigned the task of maintaining supplies. A list of all equipment and supplies must be prepared. Regular inventory will tell what has been used and what must be ordered. A pad and pencil located in the supply area to record needs as they occur will make it easier to remember items needed. A list of suppliers with names and telephone numbers or sales representatives should be prepared and kept up to date.

An accurate file of operating manuals, warranties, and service personnel for all equipment should be prepared and maintained. One factor to consider in the purchase of equipment is the availability of maintenance service.

All supplies should be kept where they are easily accessible, yet protected from damage. The storage of chemicals requires special planning.

Here are some tips to remember when *storing chemicals:*

1. Chemical supplies should be stored in a cool, dark place—preferably in a cabinet behind closed doors. Sunlight causes deterioration of most chemicals.
2. Do not store strong acids next to bases.
3. Never use metal lids on the containers of acids and bases because metal will corrode.
4. Poisons should be stored separately from other products routinely used in the laboratory. They should be labeled clearly as *poison.* Most poisons are packaged with a distinctive cap to make identification easier.
5. Flammable materials must be stored away from heat.
6. Narcotic drugs must be stored in a locked cabinet that is out of sight, or at least inconspicuous (not easily noticed).
7. Every bottle must have a legible label. It is best to keep the original label, but replacement labels must be an accurate, identical copy of the original.

Some logical method of glassware storage must be devised in the laboratory for both efficiency in use of the equipment and to avoid breakage. Glassware must be easy to find, whether it is stored by size, type, use, or a combination of all three. Pipettes and test tubes are usually stored in drawers built to hold specific sizes. Other glassware is stored on accessible shelves. Open glassware that is not used often should be stoppered to keep dust out.

Large pieces of equipment should be stored out of the way. That which is most frequently used should be most accessible. The lavish use of labels helps to identify materiéls quickly. Such labels may indicate not only the name of the equipment, but also what test it is used for.

In storing equipment and supplies, it is important to choose a method that will be most efficient for your particular laboratory and one that can be easily followed by all employees using the equipment.

UNIT 3

Safety in the Laboratory

Objectives: After completing this unit, you will be able to—

1. explain procedures for fire prevention and control;
2. dispose of contaminated materials and equipment safely;
3. follow safety procedures in operating laboratory equipment;
4. follow the procedure for heating liquid in a test tube;
5. identify safety practices in the laboratory;
6. use the safety shower;
7. wash eyes;
8. explain the procedure and purpose of reporting accidents; and
9. identify the hazards indicated by the National Fire Protection Association emblems.

New Terms and Definitions

corrode—to wear away gradually by the action of chemicals.
extinguish—to put out or quench; to cease burning.
flammable—easily set on fire.
hazard—danger, risk.
incinerate—to burn to ashes.
legible—easy to read.
liability—under legal obligation; responsible for.
safety—freedom from danger, risk, or injury.

Laboratory Hazards

Safety means freedom from danger, risk, or injury. The clinical laboratory contains more potential hazards than any other area of the medical facility. Personnel in the laboratory use hazardous materials such as glass, chemicals, infectious materials, radioactive materials, or compressed gases in their daily work. They use pipettes for transfer, microtome blades for tissue preparation, needles, open flames, and explosive chemicals. The list of potential dangers is a long one. In order to avoid injury and danger to yourself and to others, it is important to *always be aware of hazards* and to *practice safety methods.*

Fire Safety

All laboratory personnel must be responsible for fire prevention and control. You will remember that three factors must come together before a fire can begin—fuel, oxygen, and heat. This is called a fire triangle (fig. 1). If one factor is missing, the fire cannot start.

Fire Equipment

Most laboratories have the following equipment to control fires: fire extinguishers, fire blankets, and fire doors. *Fire extinguishers* are of various types, such as dry chemical, carbon dioxide, soda-acid, and pressurized water. You

should be sure you know the location of the fire extinguisher in your laboratory, and how to use it.

A *fire blanket* is used to put out flash fires of clothing. (Chemical extinguishers may be harmful to the skin.) To use a fire blanket, you grasp the rope handle, place the right arm through the rope loop, and pull vigorously while turning to the left. This wraps the person in the blanket as it is unrolled and extinguishes the fire.

A *fire door* is a heavy, fireproof door (doors) located between defined areas of a building. In case of fire, the doors are closed to help contain the fire.

Flammable Chemicals

Flammable chemicals require special care. They must be stored in a designated area, preferably in a fire safety cabinet. They are never used near an open flame. To dispose of empty containers of flammable chemicals, first fill to overflowing with tap water. Repeat several times. Then drain the containers, and place them in a special disposal area.

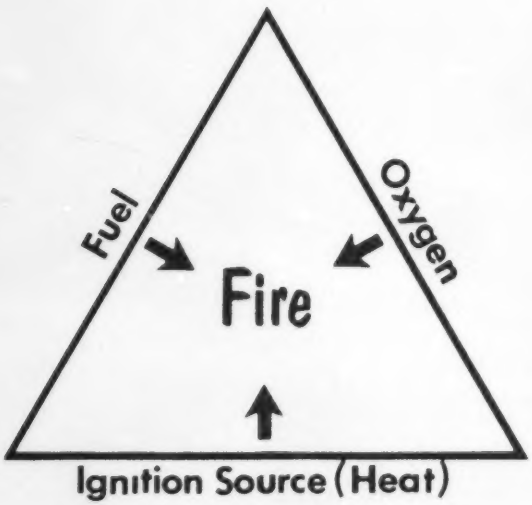

Fig. 1. Fire triangle

Routines to Follow in Case of Fire

There are several things you must learn so thoroughly that you will be able to act quickly and efficiently if a fire should start. You must know the *fire code* used where you work. Every laboratory has a fire code to alert personnel without alarming patients and visitors. You must know your exact *responsibility* in case of fire, and *how to report a fire*. You certainly must know *exit routes* from the laboratory. All of these things are included in fire drills, which are held at regular intervals in most medical facilities. When fire drills are conducted, you should cooperate fully and realize the importance of the exercise. Your life may depend on it.

Disposal of Contaminated Materials

A serious problem in the laboratory is the safe handling of infectious materials. *All infectious specimens are dangerous.* Specimens from patients with viral hepatitis and tuberculosis are especially so.

Discarded sputum specimens should be disinfected with sodium hypochlorite (bleach), then autoclaved. Finally, the entire specimen is placed in a heavy plastic bag labeled CONTAMINATED and incinerated.

Materials that may be contaminated with hepatitis viruses must be autoclaved before disposal. This includes specimens from the patient, as well as laboratory materials such as sponges, glassware, syringes, and needles. Large equipment that cannot be autoclaved may be soaked in bleach.

In case of spills of contaminated matter (blood, body fluids, or laboratory solutions), cover the entire area with paper towels. Then flood with bleach. Next, using protective gloves, place soaked towels and spillage in a container for autoclaving. Flood again with bleach. Finally, clean as usual. Then you must attend to your personal cleansing. Wash your hands, and perhaps change your uniform.

Other contaminated specimens are returned to the original container, placed in bags labeled CONTAMINATED, and incinerated. Dispo-

sable laboratory equipment is similarly treated. Reusable equipment is soaked in disinfectant, then autoclaved.

It must be mentioned that these precautions are needed to protect laboratory personnel from infection. You must also keep in mind your responsibility for the protection of workers in housekeeping or sanitation who are responsible for the final deposition of laboratory specimens. Be sure every container that leaves the laboratory is safe for anyone else who must handle it.

Safety Practices in the Use of Laboratory Equipment

Laboratory equipment in itself may be dangerous. Glassware can be particularly hazardous (fig. 2). Never use broken or chipped glass equipment. The time lost due to cuts from such equipment is more costly than replacement. If you break glassware, make sure you clean up every particle. A soft, dampened paper towel is good for picking up small pieces of broken glass.

In cutting glass tubing or forcing it into stoppers, always cover the tubing with a cloth to avoid cutting your hand.

Sharp objects used in the laboratory may be dangerous. If disposable needles are used, you must break the shaft in two before discarding them. Needles and lancets should be discarded in a designated container rather than in the general trash can. Microtome blades must be used with greatest care.

Fig. 2. Broken glassware can be especially hazardous.

Heating Liquid in a Test Tube

You may need to heat liquid in a test tube for a given test. If so, follow this procedure. Use a test tube holder. Direct the mouth of the test tube away from yourself and others. Agitate the tube gently, and heat gradually just below the surface of the liquid. *NEVER* heat flammable liquids in an open flame.

Use of the Safety Shower

A safety shower is part of the safety equipment in all laboratories. It should be centrally located and easily accessible to all workers. It is used to flush corrosives from the skin and clothing. Pulling the handle causes a large amount of water to flood the victim immediately.

Eye Wash Station

An eye wash station is a special small sink designed to direct water into the eyes. It is usually located close to the area where strong chemicals are used. If you should splash any toxic substance into your eyes, go at once to the eye wash station, and flood your eyes with water. Continue to flush the eyes with water for 15 minutes, or until medical treatment is begun. Keep your eyes open while flooding. The first 15 seconds after an accident to the eyes are crucial to the preservation of sight.

Safety Practices in the Laboratory

There are many general safety practices that should be followed:

1. Always clean spills from the work area and floor immediately.
2. Report broken or hazardous equipment to your supervisor.
3. Never leave storage drawers open or cabinet doors ajar.

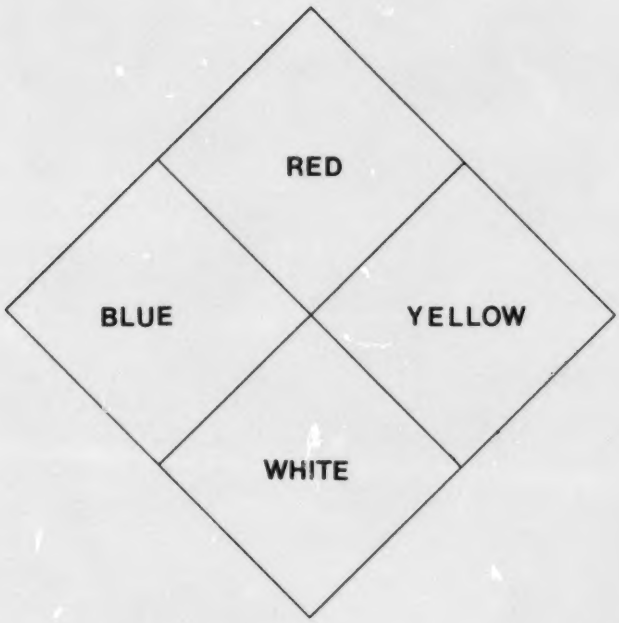

Fig. 3. NFPA Emblem and Hazard Identification symbols. (Reprinted by permission from NFPA 49-1975, Hazardous Chemical Data. Copyright ©1975, National Fire Protection Association, Boston, MA.)

4. *Always* use a rubber bulb or plugged pipette to transfer infectious material.
5. When collecting specimens, be sure to check the patient's identification.
6. Do not use frayed or damaged electrical cords.
7. All reagent bottles must be labeled and the labels must be legible.
8. Always read labels three times—as you reach for the bottle, as you pour from the bottle, and as you replace it.
9. Do not keep food of any kind, such as lunches or cold drinks, in the laboratory refrigerator. (A separate refrigerator for employees' food is a real benefit.)

Reporting Accidents

In spite of all efforts to practice safety, accidents may occur. If so, you must report the accident to your supervisor at once. The victim must be given proper first aid. Prompt corrective action must be taken if needed.

In some cases a written report of the accident must be prepared. It should include—

1. a description of the accident;
2. the time, place, and cause of the accident; and
3. names of witnesses.

The accident report may be used for claims for worker's compensation or possible liability suits.

Emblem of National Fire Protection Association

The National Fire Protection Association (NFPA) has devised an emblem that indicates the presence of hazardous materials at a glance. All facilities that must have hazardous materials are advised to put this emblem on the outer door. This makes it easier for emergency personnel to determine problems quickly.

The symbol is a diamond divided into four equal parts, or smaller diamonds. Each small diamond is a different color. Blue indicates Health Hazard, red is for Flammability, and yellow indicates Reactivity (stability). These are always arranged in the same pattern (see fig. 3). Health Hazard (blue) is indicated in the left diamond, Flammability (red) at the top, and Reactivity (yellow) at the right. The bottom diamond is left blank. It is to be used to identify other hazards. Such hazards include "Biohazard," "Radioactive," "Do not use water," "Flammable," "Flammable solid," "Corrosive," and "Sulfuric acid."

UNIT 4

Collection and Transport of Specimens

Objectives: After completing this unit, you will be able to–

1. collect blood samples;
2. collect fecal specimens;
3. collect urine specimens;
4. prepare specimens for testing; and
5. prepare specimens for shipment.

New Terms and Definitions

ambulatory–capable of walking; not bedridden.

anticoagulant–substance that prevents blood from clotting (coagulation).

blood plasma–the liquid part of the blood that has been prevented from coagulating.

blood serum–the clear liquid part of the blood after coagulation.

catheter–a tube put in the body to permit injection or withdrawal of fluids.

distal–farthest from the center.

hemolysis–the rupture of red blood cells with the release of hemoglobin into the plasma or serum.

lancet–a sharp-pointed, two-edged surgical knife.

rapport–a relation marked by harmony.

residual–left over.

supernatant–the clear liquid remaining at the top after the heavier parts settle to the bottom.

tourniquet–device for stopping bleeding by compressing a blood vessel.

venipuncture–puncture of a vein, usually for withdrawing blood.

Collection of Blood Samples

Blood samples are used for many laboratory investigations. If more than a few drops are needed, blood is collected by **venipuncture.** It is very important to establish rapport with the patient before you begin this procedure. You will need to identify yourself and tell the patient why you are there. You must carefully identify the patient, use the name tag and bed tag, and call the patient by name. Review the doctor's orders to make sure you are collecting the correct amount of blood and that you have prepared the correct containers to receive the specimen.

You should appear calm, reassuring, and sympathetic to the patient. Remember that, although you may collect many blood specimens every day, the procedure is probably new and frightening to the patient.

You should place the patient in a comfortable position. Ambulatory patients should be seated so there is a place to support the arm. Bed patients will remain in bed.

It is wise to briefly explain the procedure for venipuncture to the patient, but avoid going

into detail about the tests to be performed. Your information may confuse the patient. The doctor will explain the tests to the patient. You should explain to the patient that there is little discomfort and no residual effect from venipuncture.

Venous blood is usually taken from veins in the inner bend of the elbow (fig. 1). If for some reason the elbow cannot be used, or if you have difficulty getting blood from these veins, other sites may be used. These include the lower arm, wrist, back of hand, fingers, lower leg, ankle, or upper surface of the foot. However, these veins are usually very small although they may appear large. They have a tendency to roll, and they may have toughened walls. Therefore, the veins in the elbow are almost always most satisfactory for venipuncture.

You will need to assemble your equipment before you collect blood. If you are *using a syringe,* you will need sponges, a tourniquet, a syringe with a needle, test tubes, and slides if required.

Next, you will select the site for puncture. Place the tourniquet above the site, and tie it with a slipknot so it can be removed with one hand. Ask the patient to open and close the hand, causing the veins to become congested. Then choose a vein that is clearly evident and seems so well supported by tissue that it will not roll.

Cleanse the area with a sponge and antiseptic such as alcohol or soap solution. Dry with a sterile sponge, or air-dry.

Insert the needle cleanly and rapidly with the bevel upward. Pull back on the plunger. As blood appears in the barrel of the syringe, you are assured that the needle is in the vein. Then release the tourniquet, and collect the amount of blood required.

Place a sponge over the puncture site, but do not apply pressure until the needle is withdrawn. Then apply pressure firmly, and flex the arm until bleeding stops. Caution the patient that a bruise will result if the wound is allowed to bleed.

Make blood smears if required. Then remove the needle from the syringe, and carefully distribute blood to the indicated containers. Do not force blood through the needle, nor handle roughly, because this may cause the red blood cells to rupture with resulting hemolysis. Label all tubes and slides. Check to be sure the patient is all right, then dismiss the patient or leave the room. Be sure to take all of your equipment with you.

Fig. 1 Taking venous blood.

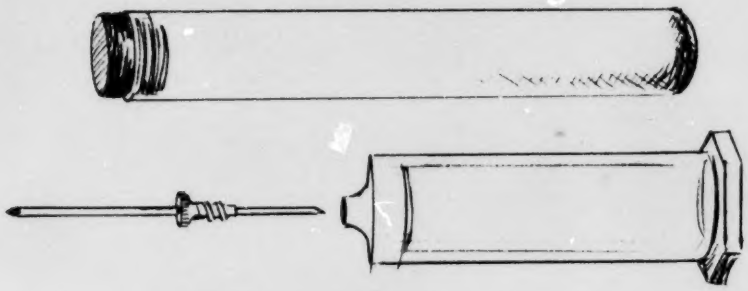

Fig. 2. Equipment for collecting blood

If you are *using a vacuum tube* to collect blood, the procedure is similar. You will assemble sponges, a tourniquet, vacuum tube, and needle. Screw the needle into place on the adapter (holder).

Place the tube loosely into the holder contacting the double-pointed needle, but not puncturing the stopper.

Follow the procedure used for collecting blood with a syringe to prepare the patient and insert needle.

After the needle end is correctly inserted into the vein, push the stoppered tube firmly onto the adapter point of the needle, puncturing the stopper. Continue to aspirate until the tube fills to the predetermined amount. Vacuum tubes will not fill completely.

If *multiple samples* are needed, remove the first tube, and rapidly replace it with a second, third, etc. Be very careful to keep the needle in place inside the vein as you change tubes.

When all specimens have been collected, remove the needle, and care for the patient as described earlier. Label all tubes carefully. Then you may dismiss the patient. Always thank patients for their cooperation, and leave with a friendly attitude.

After blood specimens have been collected, you must be sure that they are properly labeled. The label should include the patient's name and number, the doctor's name, the date, and the test required. It may include the name of the collector, the patient's room number, and the time of collection, or any pertinent information.

For some tests, *uncoagulated blood* is required. An anticoagulant is a substance that prevents clotting of blood. Since various anticoagulants are available, be sure to select the correct one for the test to be done.

After blood has been collected and tubed, it must be handled carefully until it reaches the laboratory. Blood placed in a test tube containing an anticoagulant must be inverted gently to mix.

If serum is needed for a laboratory test, *whole blood* is collected in a plain tube. It should not be inverted or mixed. Mixing may cause hemolysis of the serum. You should allow the blood to clot for 30 minutes at room temperature. Then carefully dislodge the clot from the tube wall by moving a clean applicator stick around the test tube. Decant or pipette the serum into a clean test tube, and label.

Blood placed in a test tube containing thrombin or SST is inverted and can be centrifuged after 5 minutes.

Caution must be taken to *prevent hemolysis* of blood. The following tips will be useful:

1. Use a sharp, smooth needle of appropriate size, usually 20 or 22 gauge.
2. Enter the vein as directly as possible.
3. Do not tie the tourniquet too tightly, and release it before aspirating blood.
4. Use only a dry syringe and tubes.
5. Remove the needle before distributing blood to tubes.
6. When an anticoagulant is used, mix blood gently by inverting stoppered tube. Don't shake the tube.

7. If serum is needed, allow clot to form before centrifuging.

Capillary blood is collected when a few drops are enough for testing. Usually the specimen is collected from the ring finger or middle finger. The earlobe may be used if fingers are thick-skinned or very rough, or if the patient will be handling contaminated materials. The toe is used if neither a finger nor an earlobe is available. In infants, either the toe or the heel is used.

The first step in **collecting capillary blood** is the same as that for venipuncture. Establish rapport with the patient, and identify yourself. Identify the patient by means of name tag and bed tag and by calling him or her by name. Review the doctor's orders.

Then you are ready to assemble the needed equipment. You will need sponges, a sterile lancet, microtubes and/or blood pipettes, slides, diluting fluid if needed, and adhesive bandage.

Next, select the site to puncture. Never use an area that is swollen, scarred, calloused, or bruised. Cleanse the area with a disinfectant sponge, and wipe with a dry sponge. (If the site is wet, the blood will spread out instead of forming a drop.)

Grasp the finger firmly across the middle or first joint (fig. 3). The patient may involuntarily move if you do not hold the finger securely. Quickly puncture the skin with a sterile, disposable lancet. Wipe off the first drop of blood. To take advantage of gravity, keep the patient's hand conveniently low. Using gentle pressure on the finger, fill containers as ordered. Do not allow air bubbles to form in collection tubes or pipettes. Collect with a continuous flow of blood. Hold up the distal end of the collection tubes. Then seal the ends of capillary tubes with clay.

Finally, prepare blood smears on microscope slides if requested. Then cleanse the finger with a disinfectant sponge, and apply pressure with a dry sponge to stop bleeding.

When the procedure is complete, be sure the patient is all right. Thank the patient for cooperating, and then dismiss her or him. If the

Fig. 3. Collecting capillary blood

patient is in a hospital, be sure to collect all your equipment and the specimens before you leave the room.

Collection of Fecal Specimens

Laboratory tests on feces are important in diagnosis. The patient should be carefully instructed in the method of collection to ensure a satisfactory specimen.

Hospital patients are given a clean, dry bedpan for defecation. Nursing personnel will collect the specimen and send it to the laboratory.

If the patient is to collect the specimen, then he or she must fully understand *what* is to be collected, *how* it is to be collected, and *what* container should be used. The following general instructions will be helpful:

1. The specimen must not be contaminated with urine.
2. No laxative should be taken unless it is ordered by the doctor.
3. A wide-mouthed container with a tight-fitting lid and a few wooden tongue blades should be provided.
4. The patient may defecate in a clean, dry bedpan or on a clean paper plate.
5. The patient will collect a small amount of feces (size of a pecan), place it in the container, and cover securely. The patient must take care to avoid contaminating the outside of the container.
6. Finally, the patient must wash hands, attach completed label, and return the specimen to the laboratory.

The information on the label should include the patient's name, the time and date of collection, the name of the doctor, and any other pertinent information.

Fecal material collected by the doctor during rectal examination is sometimes sent to the laboratory for study.

A variety of tests may be performed on fecal specimens. Some of these require very specific instructions for collection. Details such as preservatives, special containers, exact time of collection, or a constant temperature may be important. Such instructions should be made very clear to the patient. Some examples of types of tests are these:

1. Gross examination for consistency, color, mucus, or blood.
2. Occult blood.
3. Detection of ova and parasites.
4. Viral and bacterial cultures.
5. Detection of ameba; trophozoites and cysts.

Collection of Urine Specimens

Perhaps the most common laboratory procedure is the urinalysis, which is a series of tests done on urine.

A routine urinalysis means the series of urine tests selected by a given institution to be performed on most urine specimens. Usually, a routine urinalysis includes a gross examination of appearance, reaction, simple chemical tests, and a microscopic examination of sediment. A *routine specimen* means a urine specimen collected at any time during the 24-hour day. Such a specimen will vary in concentration depending on the patient's liquid intake. Sometimes the first urine specimen collected in the morning is preferred because it will be more concentrated. A routine urine specimen is almost always collected upon admission to the hospital or when visiting the doctor's office.

For some tests, a *24-hour* urine specimen is needed. This means that the entire quantity of urine voided for 24 hours is collected and sent to the laboratory for testing.

Sometimes, a *midstream or "clean catch"* urine specimen is preferred. This means the specimen is essentially free of contamination. The patient is instructed to clean the urethral area if female, or glans if male. (In the hospital, nursing personnel will assist the patient.) The patient then begins to void into the toilet. This rinses the urethra. The midstream urine is collected in a clean container. The remaining urine is voided into the toilet. If the midstream specimen is to be used for bacteriologic studies, a sterile container must be used.

Rarely, catheterization is used to obtain clean urine specimens for bacteriologic study. Such procedures are infrequently ordered

because the use of the catheter may cause urinary tract infections.

In the hospital, nursing service is responsible for the collection, labeling, and test requests for urinalyses. Specimens should be delivered to the laboratory promptly. You may be responsible for logging the specimens and assigning numbers after they have reached the laboratory.

In a clinic or doctor's office, the medical laboratory worker may be responsible for urine specimen collection. The following procedure may be used:

1. Provide a clean, dry container.
2. Ask the patient to provide a urine specimen.
3. Tell the patient the location of the rest room and where the collected specimen is to be placed.
4. When the specimen is returned, label it properly, and provide the proper report form.
5. Perform the tests as soon as possible. If there must be a delay, refrigerate the urine specimens. Bacteria multiply rapidly, and leucocytes and casts tend to disintegrate at room temperature.

Urine specimen containers must be clean and dry. If they are to be used for bacteriologic examination, they must be sterile. Most hospitals use plastic, disposable containers. Plastic, glass, or metal containers are commonly used in smaller laboratories because they may be washed and reused. Occasionally, a patient may be asked to collect a urine specimen at home. It is advisable to provide the patient with a specimen container. This way you can be sure the container is clean and uncontaminated.

Preparation of Specimens for Testing

The medical laboratory worker may be asked to *process specimens.* This means the preparation of specimens for actual analysis after they have been collected.

The various tests done on blood require different preparations. Whole blood should be kept in the original stoppered container until it is ready for analysis. If there is a delay of more than an hour between collection and testing, then the specimen should be stored in the refrigerator.

Some blood tests are done using serum. Serum is the liquid part of blood that remains when a clot forms. To process a blood specimen for serum collection, you first allow the blood to clot. Then, rim the tube with an applicator to loosen the clot. Next, centrifuge the specimen, and collect the supernatant serum. Serum may be frozen if analysis is delayed more than 4 hours.

If an anticoagulant is added to whole blood, the liquid part of the blood in which the cells are suspended is the plasma. To collect plasma, you must centrifuge the blood. The cells will then collect at the bottom of the tube. The supernatant fluid is plasma. Plasma should be refrigerated if there must be a delay between processing and analysis. Plasma may be frozen if the delay is longer than 4 hours.

One problem that you must avoid in processing blood specimens is hemolysis. *Hemolysis* means the rupture of red blood cells with the release of hemoglobin into the plasma or serum.

Blood collected soon after a patient has eaten a meal may contain neutral fats. This will cause the serum or plasma to have a milky appearance and may cause error in test results. To avoid this problem, be sure to instruct the patient to fast before the blood is collected.

Other materials for laboratory testing, such as urine, feces, or bacterial studies, may require special processing, but the general rule is to examine the specimens as quickly as possible after collection. If prompt analysis is impossible, then use the appropriate means to preserve the specimen.

Preparation of Specimens for Shipment

Specimens may be sent to laboratories outside your medical facility for various reasons. A primary concern is cost. It is less expensive for some medical facilities to send laboratory work

to a laboratory that does a large volume of work than to maintain a complete laboratory with trained personnel for their small number of tests.

Another reason is convenience. Often routine laboratory tests are performed on site while the patient is waiting. Tests other than routine are sent to outside laboratories. By concentrating on routine tests, laboratory personnel will have time to handle these tests for the normal flow of patients.

Individual preference is another reason for sending specimens to an outside laboratory. Some physicians, patients, and insurance companies prefer to have tests performed in a laboratory other than the facility in which the specimen is collected.

Finally, many complex laboratory tests are difficult to perform with reproducible results. Therefore, the expertise and equipment required is a reason for sending specimens to another laboratory. The more complex tests that are infrequently ordered are sent to laboratories where large numbers of such tests are done. These laboratories have the time, space, equipment, and personnel to perform such tests.

Before you can prepare the specimens for shipment, you must know what kind of specimens are needed for the exact tests requested. Requisition slips must be carefully prepared noting all relevant information. Examples of information needed are patient's name, address, phone number, age, sex; the sending clinic or hospital; chart or room number; the doctor's name and address; a description of the specimen; and tests ordered.

Some specimens need special preparation before they are sent out. Plasma or serum may be separated from whole blood. If a preservative or anticoagulant is used, be sure it is the correct one. Some specimens even require special temperatures or sprays. The special preparations ensure that the specimen will arrive safely and intact.

Specimens must be mailed in appropriate containers following specific instructions. For example, frozen specimens are packed in dry ice. Acute and convalescent samples are sent at the same time. Of course, these must be very carefully labeled to distinguish them. Containers used should prevent spillage or breakage. Addresses must be clearly typed or printed. Some laboratories will provide containers for mailing specimens.

Commercially prepared containers designed to protect contents are available. These can be obtained in a variety of shapes and sizes to fit almost any specimen, such as test tubes, urine containers, or slides.

A variety of specimens may be sent to laboratories outside your medical facility. Included are whole blood, blood serum, or plasma; smears of blood or bacteria; Papanicolaou smears; specimens of urine, feces, or sputum; or tissue from biopsy or resection.

There are also a variety of laboratories that might receive such specimens. They may be sent to city, county, state, or federal public health laboratories. There are many research facilities and medical schools where specimens may be sent. Insurance company laboratories sometimes require that specimens be sent to their facility. Many private laboratories are equipped to perform complex laboratory tests.

The decision whether to perform a given test at your medical facility or to mail it to another laboratory depends on many factors. Whatever choice is made, the primary deciding factor should be to make available to patients the best possible laboratory service at the lowest possible cost.

UNIT 5

Use and Maintenance of Laboratory Equipment

Objectives: After completing this unit, you will be able to–

1. use a centrifuge;
2. identify a microhematocrit centrifuge;
3. recognize a refrigerated centrifuge;
4. identify the parts of a compound microscope;
5. use a compound microscope;
6. identify volumetric and calibrated pipettes;
7. measure solutions with a pipette;
8. use a water bath or heat block; and
9. check the temperature of constant temperature appliances.

New Terms and Definitions

auxiliary–additional; assisting.
calibration–mark to indicate a given amount or size in measuring.
centrifuge–a machine that spins at high speed used to separate materials of different densities.
constant–always the same.
fluctuation–change by rising and falling at intervals.
graduated–marked for use in measuring.
lethal–deadly; capable of causing death.
manual–done with the hands.
meniscus–the curved upper surface of a column of liquid.
pipette–a slender glass tube used for measuring and transferring liquids.
precision–accuracy; exactness.
sediment–the substance that settles at the bottom of a liquid.
thermostat–an automatic device that regulates or controls temperature.
velocity–speed; rate of motion.

The Centrifuge

The centrifuge is one of the most commonly used pieces of equipment in the laboratory (fig. 1). It is a machine that spins at high speed. Centrifugal force causes substances of different densities to separate. Heavier particles fall to the bottom. Lighter particles and fluids collect above.

Centrifuges are used in laboratories for many things. These include the separation of serum or plasma from whole blood, bacteria from liquid media, to concentrate the sediment in urine for microscopic examination, or to separate cream from milk. In short, in any situation where you need to separate substances of different weights, a centrifuge is used.

Centrifuges vary a great deal in size, but they must all be used with great care. If even a light object is propelled with great velocity, it

becomes lethal. Table models should be placed on a sturdy bench or table where there is plenty of room for the machine to spin. They should not be placed near the more delicate or sensitive equipment that might be affected by the vibration of the centrifuge. Large models are usually bolted into concrete on the floor.

Any items put in the centrifuge must be placed so that they balance each other. For example, if only two test tubes are used, they must be of the same weight and placed exactly opposite each other. In using large centrifuges, specimens are weighed to be sure they balance. This helps to avoid damage to the centrifuge, breakage of specimen tubes, and danger to personnel. The lid of the centrifuge must be securely closed before the machine is turned on. Speed should be accelerated slowly.

After the centrifuge has been turned off, it will of course stop spinning gradually. Most machines have a brake to be used if needed. Do not use the brake to stop the machine just because you are in a hurry and do not want to wait until the machine stops spinning. *Never stop the machine with your hand.* You may injure yourself, the specimens, the centrifuge, or all three! If breakage occurs while the machine is running, quickly turn off the power supply, but NEVER open it until it is completely stopped.

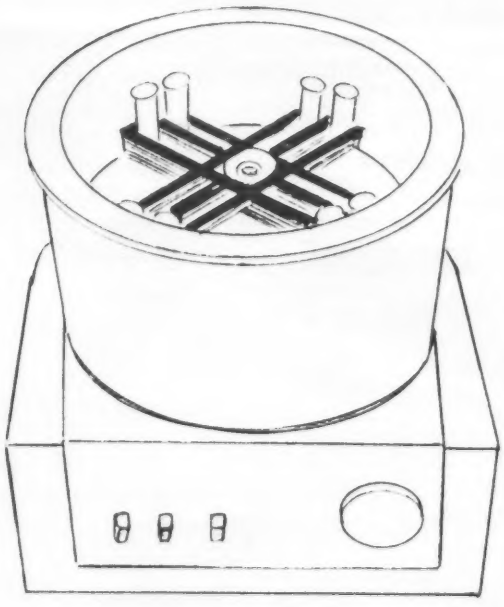

Fig. 1. Centrifuge

The inside and outside of the centrifuge should be kept free of dirt with mild detergent and water. Spills should be cleaned at once. The machine should be left covered with the lid when not in use to keep dirt and debris out. You may use a test tube brush to clean test tube carriers. If breakage should occur, you must remove all fragments and clean all parts at once.

If the centrifuge needs repair, check the operating manual for repair suggestions and for the name and address of repair personnel.

A special type of centrifuge is used in performing a *microhematocrit.* It is specifically designed to hold the capillary tubes required for the test. The purpose of a microhematocrit test is to determine an accurate packed cell volume of red blood cells using small quantities of blood. The centrifuge operates at very high speeds, from 11,000 to 15,000 rpm. The machines are usually equipped with an automatic timer because an exact centrifuge running time is required to produce constant test results. The accuracy of the timer should be checked at frequent intervals with a stopwatch or an electric clock.

A *refrigerated* centrifuge is exactly what the name implies. It is a centrifuge cooled by mechanical refrigeration with a thermostat to keep the temperature constant. This protects heat-sensitive specimens from the heat generated by the centrifugal force of the spinning. These are used in some blood banks and in the preparation of biological specimens.

The Microscope

The microscope is another commonly used piece of equipment. Its purpose is to magnify very small objects. There are many kinds of microscopes. They are designed for different specific uses and vary in price. The first microscopes were simple microscopes.

A *simple microscope* is merely a single lens or magnifying glass. Some simple microscopes can magnify 200×. A *compound microscope* is a series of lenses to increase magnification and will magnify up to 1000×.

If the microscope has a single eyepiece (ocular), it is *monocular*. These microscopes are commonly used to teach students how to use the microscope. *Binocular* microscopes (two eyepieces) are used in most laboratories. Teaching microscopes have two sets of eyepieces (four total) so the instructor and student may see the same field at the same time.

- The **fine adjustment wheel** moves either the stage or objective minimally for fine focusing.
- The **coarse adjustment wheel** moves either the stage or objective maximally for the first sighting of the object.
- The **objectives** contain lenses for magnification.
- The **substage control** moves the stage for focusing (not found on all microscopes).
- The **oil-immersion objective** is a special objective on some microscopes. It is designed to be used with a drop of immersion oil between the object and the surface of the lens.

One of the most important skills the medical laboratory worker must learn is the use of the microscope. The correct procedure is given in the following steps.

Turn the *nosepiece* until the low-power objective is in place. You will feel and hear a click.

Then adjust the *mirror* (substage lamp) with the eye at the eyepiece. If you are using a mirror, the flat side should face the stage if a condenser is used. Use the concave side if no condenser is present. Use the *diaphragm* to control the amount of light.

Now place the prepared slide on the *stage*. Using the *coarse adjustment wheel*, move the *tube* (barrel) downward until the *low-power objective* is close to the slide. Be sure to watch the tube move as you turn the coarse adjustment wheel. Never focus downward with the coarse adjustment wheel while peering through the eyepiece. This will avoid breaking slides, cover slips, and even lenses.

A *dark field* microscope is used in the identification of some bacteria. In this microscope, a special condenser causes light to reflect from the specimen onto a dark background. Thus, you see a light object in a dark field.

The *electron* microscope is used when the greatest magnification is required, such as the study of viruses. Magnifications of 400,000× are possible with this microscope.

Other kinds of microscopes used for special studies are the *polarization* microscope, the *ultraviolet* microscope, and the *phase* microscope.

Use of the Compound Microscope

A compound microscope has the following parts, as shown in figure 2:

- The **eyepiece (ocular)** contains a magnifying lens.
- The **body tube** or **barrel** connects the eyepiece to the objectives.
- The **nosepiece** supports the objectives.
- The **arm** is the support by which the microscope is carried.
- The **stage** is the part of the microscope where the slide is placed.
- The **diaphragm** makes possible the adjustment of the amount of light entering the objectives.
- The **slide clips** hold the glass slide in place.
- The **mirror** reflects light rays into the objective. (Instead of a mirror, some microscopes have a **substage lamp** to provide light.)
- The **base** supports the body of the microscope.

Place your eye at the eyepiece, and gradually move the tube upward, using the coarse adjustment wheel, until you see the object on the slide. If you fail to find the object, start over. Lower the tube again and gradually raise it. After you have found the object using the coarse adjustment wheel, use the *fine adjustment wheel* to get a sharper image. You may need to readjust the light source and diaphragm to get the best image.

Once you have focused clearly using the low-power objective, you can change to the

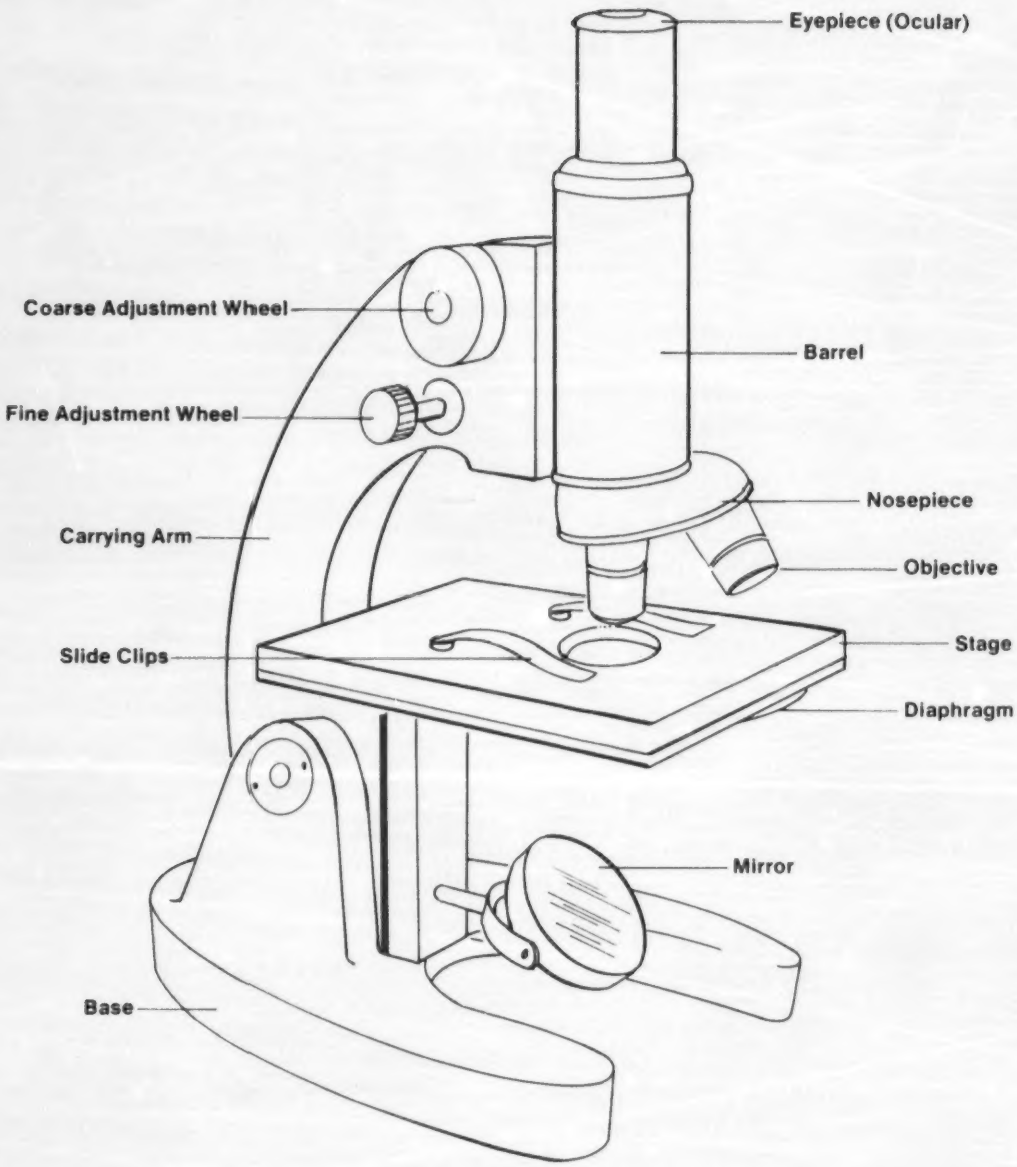

Fig. 2. Parts of the microscope

high-power objective. The image should stay in focus, but you will need to use the fine adjustment wheel to maintain a clear image.

When you have finished working with the microscope, you must remove the slide. Then clean the eyepiece, objectives, and stage with lens paper. Put the low-power objective in place, and focus all the way down with the coarse adjustment wheel. The microscope should be covered or housed in a closed case when not in use.

The magnification of the object viewed is the product of the magnification of the eyepiece multiplied by the magnification of the objective used.

Example: Eyepiece 10×
Objective 10×
Magnification 100×

To clean the microscope you must use a camel's-hair brush or soft lens paper. Xylol (xylene) may be used to remove oil from oil-immersion lenses. Since xylol is toxic, it should be used sparingly and in well-ventilated areas.

Always use both hands to carry a microscope. You should put one hand on the carrying arm and the other under the base of the instrument. Never try to carry other objects while carrying the microscope.

If your microscope does not function properly in any way, do not try to force it or fix it, but notify your supervisor (instructor) at once. Remember, a microscope is an expensive piece of precision equipment.

Use of Pipettes

Pipettes are calibrated glass tubes open at both ends. They are used to measure and transfer small amounts of liquid with accuracy. *Volumetric* pipettes are calibrated to measure a single volume, such as 1, 2, 5, or 10 ml. *Graduated* pipettes are calibrated to measure various quantities within a given amount, such as 10 ml graduated in 1 ml (see fig. 3).

It takes practice to learn to use a manual pipette with accuracy. Salt solution colored

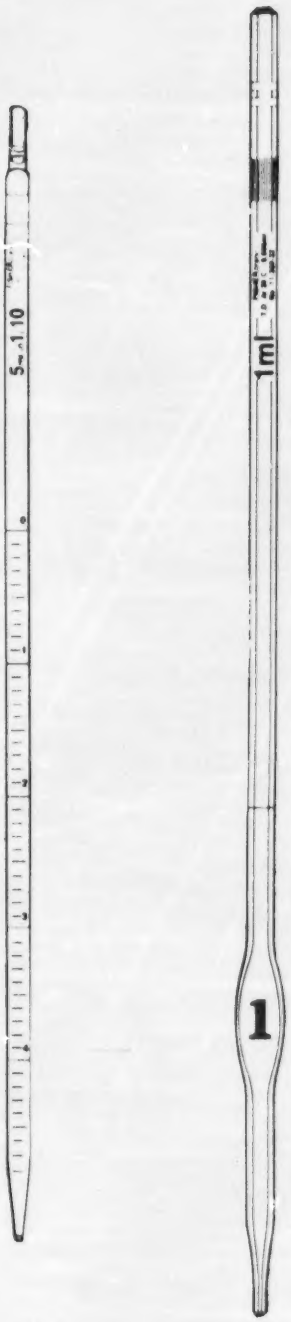

Fig. 3. Graduated pipette (left) and volumetric pipette (right)

with food coloring is a satisfactory practice medium. The following procedure should be used.

Select a volumetric pipette. Hold the stem of the pipette between the thumb and middle finger, leaving the index finger free. Do not cover the calibration with your fingers.

Place the tip of the pipette in a beaker of the colored salt solution. The tip must remain below the surface of the liquid to avoid drawing in air.

Place your mouth to the mouthpiece. Carefully draw the colored solution into the pipette well above the calibration mark. Try to keep the mouthpiece of the pipette dry.

Remove the pipette from your lips, and quickly cover the mouthpiece with the index finger, thus holding the salt solution in the pipette.

Release the pressure from the index finger to allow the salt solution to flow from the pipette gradually, until the bottom of the meniscus of the solution is at the required calibration. Then place the tip of the pipette in a second beaker and allow to drain.

In using a graduate pipette, you blow the last drop from the tip rather than allowing it to drain.

You should continue to practice pipetting until you can accurately transfer solutions.

There are **precautions to observe** in the use of pipettes. You should never use cracked, chipped, or broken pipettes. It is impossible to measure accurately with broken pipettes, and you may cut your lips or fingers. Never pipette infectious or poisonous materials. You might get some of the fluid in your mouth. If dangerous fluids must be measured with a pipette, you may plug the mouthpiece with cotton, or use a rubber bulb for suction.

Do not put pipettes which have touched any other material back into reagent bottles, because this will contaminate the entire contents of the bottle.

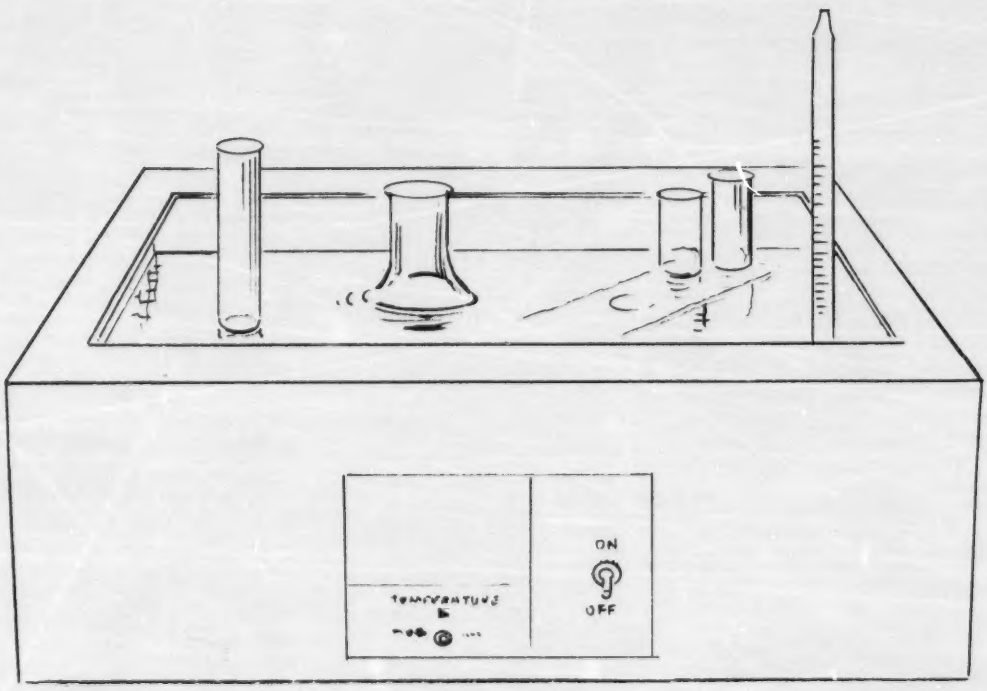

Fig. 4. Water bath

Use of the Water Bath and Heating Block

A *water bath* is simply a container of water maintained at a constant, fixed temperature (fig. 4). It is used for some laboratory tests in which specimens must be incubated at a given temperature. The temperature of the bath is controlled by a heating device and a thermostat. Some water baths have a pump to circulate the water.

In maintaining a water bath, you must be sure the pump housing and heater are immersed in the water.

A *heating block* is a solid metal block with holes suitable for holding various sizes of test tubes (fig. 5). It has a heating device and a thermostat so a constant temperature may be maintained.

Specimens incubated in a water bath emerge dripping with water. A heating block eliminates this. However, foreign materials from spillage and breakage tend to accumulate in the test tube holes of the heating block. Some particles may be removed by simply turning the block upside down and shaking. You may need to swab the holes to clean them. For thorough cleaning, you must remove the top plate. After cleaning, replace the plate.

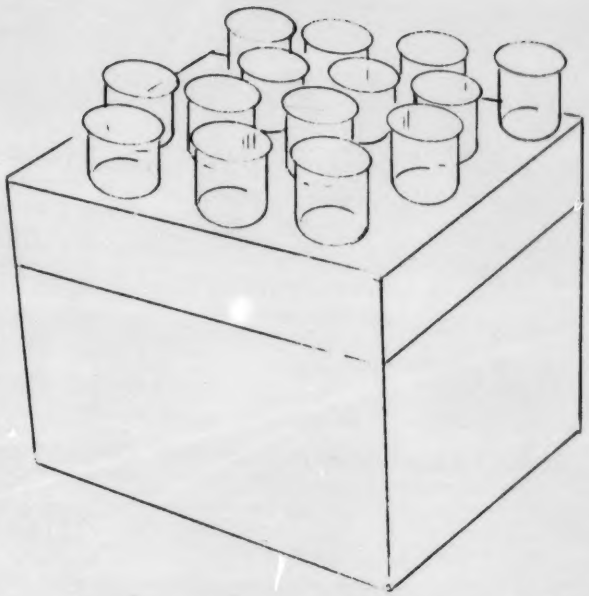

Fig. 5. Heating block

Maintenance of a Constant Temperature of Appliances

Many other kinds of laboratory equipment must maintain a specific constant temperature. For example, it is critical that the temperature of bacteriology incubators, and of ovens used for drying samples, evaporating, or sterilization, be accurately controlled. It may be your responsibility to check these temperatures at regular, designated times and to report any error to your supervisor.

Refrigerators used in blood banks usually have a device that constantly records the temperature. Thus, the time and duration of any fluctuation in temperature may be readily noted. Blood bank refrigerators should have an emergency auxiliary power source. This may be a battery or another available circuit. Some have an alarm system to warn of any critical temperature change. Such alarms may be visual, audible, or both.

General cleaning, polishing, and maintenance of various pieces of laboratory equipment is often the responsibility of the medical laboratory worker. The surfaces of most machines are of chrome, enamel, or stainless steel. A mild detergent and a sponge will remove surface dirt and water stains. The manufacturer's manual will usually describe methods for major cleaning of equipment.

A regular routine of cleaning provided by the supervisor will improve the appearance of the equipment and prolong its usefulness.

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